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Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Site Evaluation for Application of Fuel Cell Technology

Construction Battalion Center Port Hueneme, CA

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Foreword

In fiscal years 93 and 94, Congress provided funds for natural gas utilization equipment, part of which was specifically designated for procurement of natural gas fuel cells for power generation at military installations. The purchase, installation, and ongoing monitoring of 30 fuel cells provided by these appropriations has come to be known as the "DOD Fuel Cell Demonstration Program." Additional funding was provided by: the Office of the Deputy Under Secretary of Defense for Industrial Affairs & Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research & Development Program (SERDP); the Assistant Chief of Staff for Installation Management (ACSIM); the U.S. Army Center for Public Works (CPW); the Naval Facilities Engineering Service Center (NFESC); and Headquarters (HQ), Air Force Civil Engineer Support Agency (AFCESA).

This report documents work done at Construction Battalion Center (CBC) Port Hueneme, Hueneme, CA. Special thanks is owed to the CBC Port Hueneme points of contact (POCs) Gene Crank and Rich Spiessl for providing investigators with access to needed information for this work. The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Michael J. Binder. Part of this work was performed by Science Applications International Corp. (SAIC), under Contract DACA88-94-D-0020, task orders 0002, 0006, 0007, 0010, and 0012. The technical editor was William J. Wolfe, Information Technology Laboratory. Larry M. Windingland is Chief, CEERD-CF-E, and L. Michael Golish is Chief, CEERD-CF. The associated Technical Director was Gary W. Schanche. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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1 Introduction

Background

Fuel cells generate electricity through an electrochemical process that combines hydrogen and oxygen to generate direct current (DC) electricity. Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States have exempted fuel cells from requiring operating permits. Today's natural gas-fueled fuel cell power plants operate at electrical conversion efficiencies of 40 to 50 percent; these efficiencies are predicted to climb to 50 to 60 percent in the near future. In fact, if the heat from the fuel cell process is used in a cogeneration system, efficiencies can exceed 85 percent. By comparison, current conventional coal-based technologies operate at efficiencies of 33 to 35 percent.

Phosphoric Acid Fuel Cells (PAFCs) are in the initial stages of commercialization. While PAFCs are not now economically competitive with other more conventional energy production technologies, current cost projections predict that PAFC systems will become economically competitive within the next few years as market demand increases.

Fuel cell technology has been found suitable for a growing number of applications. The National Aeronautics and Space Administration (NASA) has used fuel cells for many years as the primary power source for space missions and currently uses fuel cells in the Space Shuttle program. Private corporations have recently been working on various approaches for developing fuel cells for stationary applications in the utility, industrial, and commercial markets. Researchers at U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). CERL successfully executed several research and demonstration work units with a total funding of approximately $55M.

As of November 1997, 30 commercially available fuel cell power plants and their thermal interfaces have been installed at DoD locations, CERL managed 29 of these installations. As a consequence, the Department of Defense (DoD) is the owner of the largest fleet of fuel cells worldwide. CERL researchers have developed a methodology for selecting and evaluating application sites, have supervised the design and installation of fuel cells, and have actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers. This accumulated expertise and experience has enabled CERL to lead in the advancement of fuel cell technology through major efforts such as the DoD Fuel Cell Demonstration, the Climate Change Fuel Cell Program, research and development efforts aimed at fuel cell product improvement and cost reduction, and conferences and symposiums dedicated to the advancement of fuel cell technology and commercialization.

This report presents an overview of the information collected at Construction Battalion Center (CBC) Port Hueneme, Hueneme, CA along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the Site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report (see Table 1).

Objective

The objective of this work was to evaluate CBC Port Hueneme as a potential location for a fuel cell application.

Approach

On 4 and 5 September 1996, CERL and SAIC representatives visited the U.S. Naval Construction Battalion Center (CBC) Port Hueneme (the Site) to investigate it as a potential location for a 200 kW fuel cell. This report presents an overview of information collected at the Site along with a conceptual fuel cell installation layout and description of potential benefits. The Appendix to this report contains a copy of the site evaluation form filled out at the Site.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No.
Pine Bluff Arsenal, AR	TR 00-15
Naval Oceanographic Office, John C. Stennis Space Center, MS	TR 01-3
Fort Bliss, TX	TR 01-13
Fort Huachuca, AZ	TR 01-14
Naval Air Station Fallon, NV	TR 01-15
Construction Battalion Center (CBC), Port Hueneme, CA	TR 01-16
Fort Eustis, VA	TR 01-17
Watervliet Arsenal, Albany, NY	TR 01-18
911th Airlift Wing, Pittsburgh, PA	TR 01-19
Westover Air Reserve Base (ARB), MA	TR 01-20
Naval Education Training Center, Newport, RI	TR 01-21
U.S. Naval Academy, Annapolis, MD	TR 01-22
Davis-Monthan AFB, AZ	TR 01-23
Picatinny Arsenal, NJ	TR 01-24
U.S. Military Academy, West Point, NY	TR 01-28
Barksdale Air Force Base (AFB), LA	TR 01-29
Naval Hospital, Naval Air Station Jacksonville, FL	TR 01-30
Nellis AFB, NV	TR 01-31
Naval Hospital, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, CA	TR 01-32
National Defense Center for Environmental Excellence (NDCEE), Johnstown, PA	TR 01-33
934th Airlift Wing, Minneapolis, MN	TR 01-38
Laughlin AFB, TX	TR 01-41
Fort Richardson, AK	TR 01-42
Kirtland AFB, NM	TR 01-43
Subase New London, Groton, CT	TR 01-44
Edwards AFB, CA	TR 01-Draft
Little Rock AFB, AR	TR 01-Draft
Naval Hospital, Marine Corps Base Camp Pendleton, CA	TR 01-Draft
U.S. Army Soldier Systems Center, Natick, MA	TR 01-Draft

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

1 ft	=	0.305 m
1 mile	=	1.61 km
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

CBC Port Hueneme is located approximately 50 mi north of Los Angeles on the west U.S. coast. It is an Energy Showcase site for the Navy where the latest energy technologies are implemented. The ASHRAE design temperatures for the Site are 41 °F for winter and 75 °F for summer. Extreme temperatures are 35 and 86 °F.

The CBC is the west coast homeport of the Navy's mobile construction force. Its mission is "to support the Naval Construction Force, fleet units and assigned organizational units deployed from or homeported at the CBC; to support mobilization requirements of the Naval Construction Force; to store, preserve, and ship advanced base mobilization stocks; to perform engineering and technical services, and such other tasks as may be assigned by higher authority." CBC supports the training and mobilization requirements for more than 2,600 active duty personnel. The CBC also operates a 1,600-acre naval base.

The base swimming pool was the only potential application at CBC identified by site personnel. The pool operates year round, but with only limited hours in the winter period (Labor Day through Memorial Day). It is an outdoor, 566,000-gal (12,180 sq ft surface area) pool and is generally covered at night. The pool is currently heated with steam from the CBC central steam plant through heat exchangers located in the mechanical room. Port Hueneme is phasing out its central boiler plant. The existing heating system for the pool will be replaced by new pool heating equipment beginning in 1997.

Site Layout

Figure 1 shows a site map of the CBC, Port Hueneme. The pool is located just south of the main gate. Figure 2 presents the pool layout and surrounding mechanical room and bathhouse areas. There is a 6-in. natural gas line in the street that can be tapped into to supply gas for the fuel cell. There is currently no natural gas into the mechanical room. There is a small open grassy area on the west side of the mechanical room. Overhead power lines run parallel with the sidewalk next to the street. The mechanical room will be revamped with new heating equipment, cutting off the existing centrally supplied steam system.

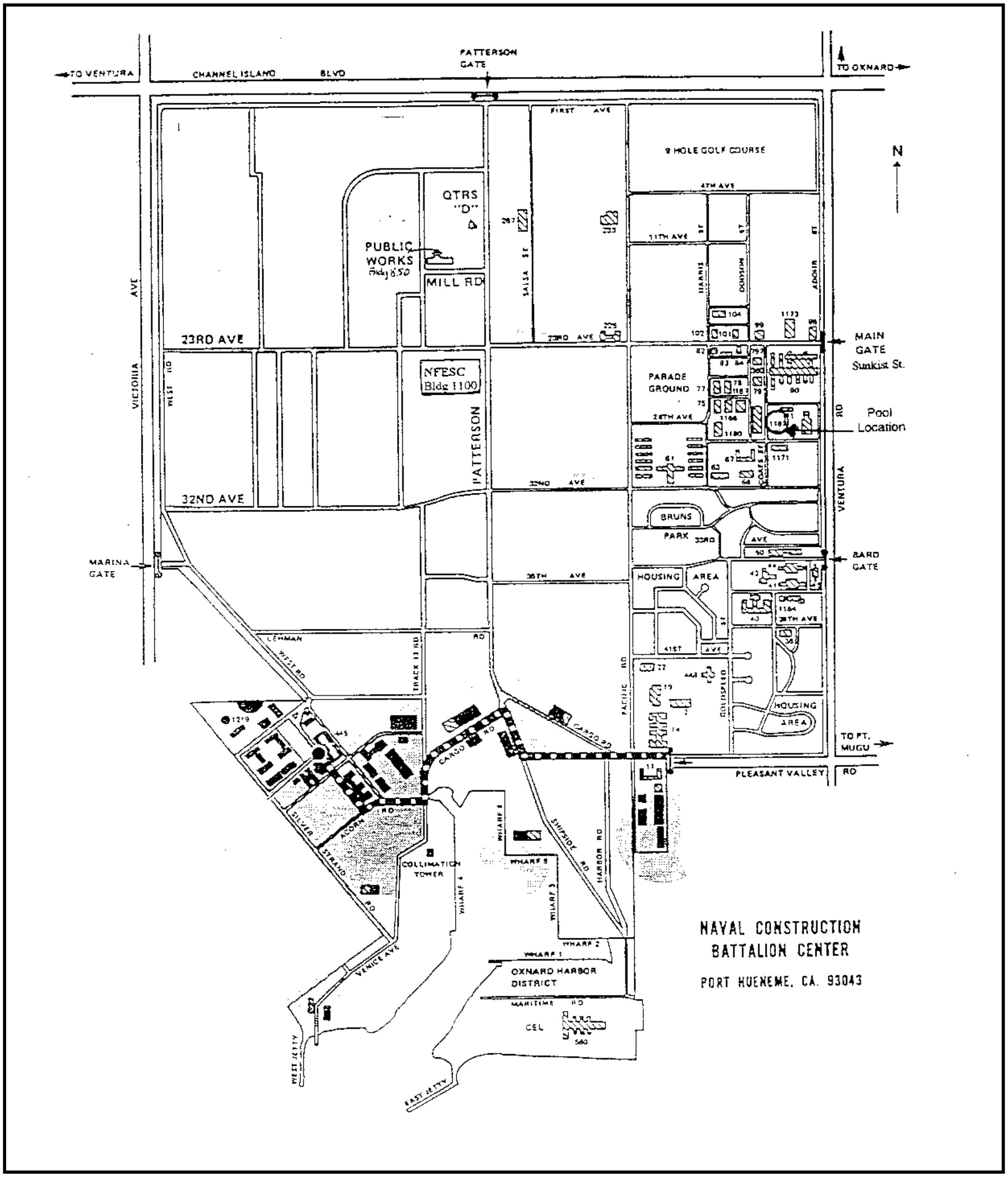

Figure 1. CBC Port Hueneme site map.

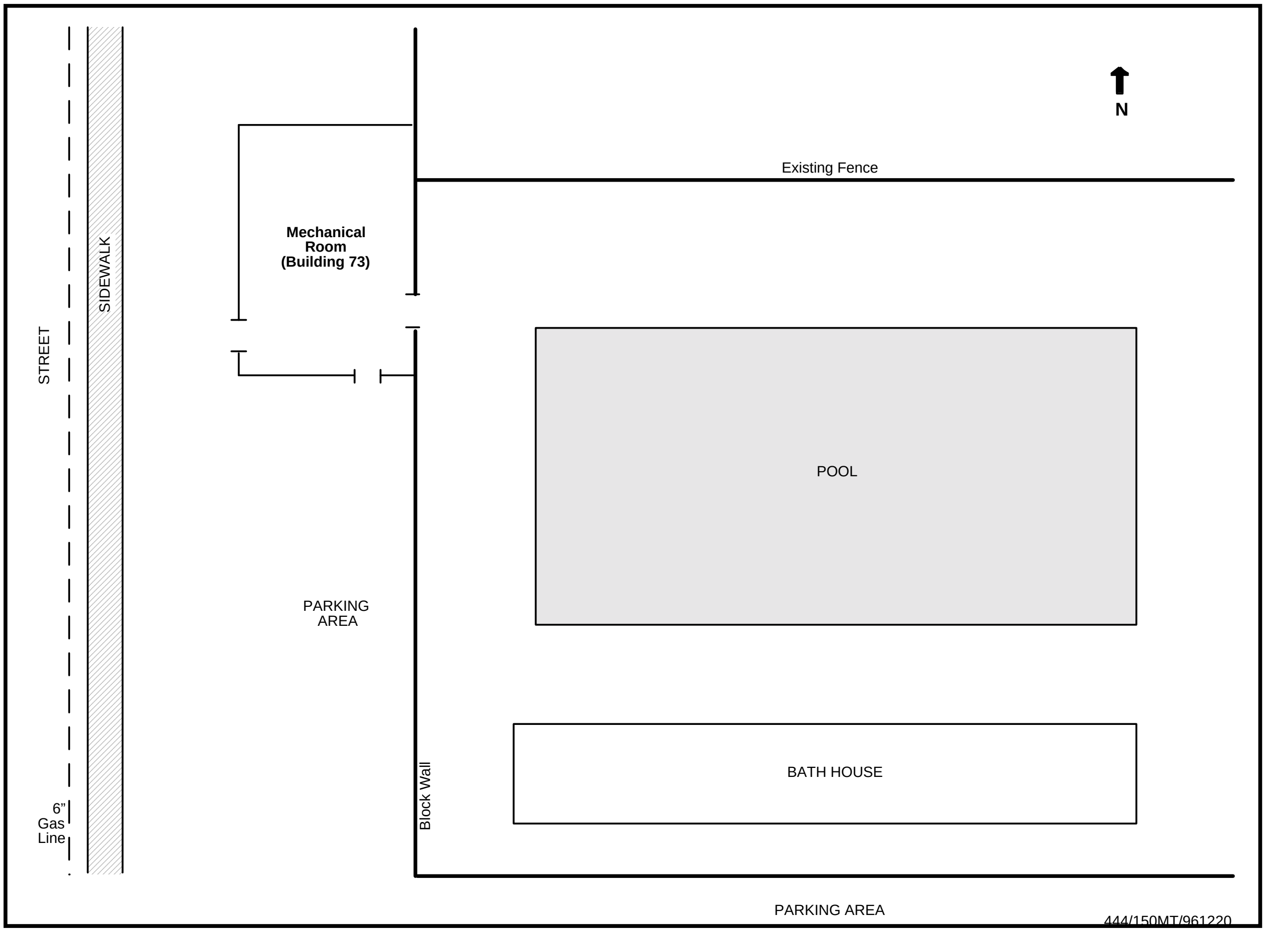

Figure 2. Swimming pool site layout, Port Hueneme.

Electrical System

The Site distributes electricity at 4,160 V, although there are plans to upgrade the entire base to 12,470 V in the near future. The pool equipment currently operates at 208 V. The new heating equipment scheduled to be installed at the pool will require 480 V power and a new transformer.

Steam and Hot Water Systems

The pool is currently heated via a central steam boiler plant/distribution system. Heat exchangers located in the pool mechanical area supply heat to the pool.

Space Heating System

There is no space heating in the mechanical room. The bathhouse has its own space heating system, but is not interfaced thermally with the mechanical room.

Space Cooling System

There is no space cooling at this facility.

Fuel Cell Location

The fuel cell should be located on the west side of the mechanical room in the open grassy area. The Navy has requested a PC25B model fuel cell for this installation. Figure 3 shows it should be oriented in a north-south direction. The cooling module can be located in an east-west direction on the north side of the fuel cell. A new pad-mounted electrical transformer should be located outside the fuel cell fenced area near the cooling module.

The fuel cell thermal piping should face the building. Thermal piping runs would be about 40 ft. Piping to the cooling module will be 20 ft. The electrical run to the new transformer would be about 15 ft. Natural gas should be brought in from the street, about 20 ft. The nitrogen piping run will be about 25 ft.

Fuel Cell Interfaces

The fuel cell will operate in the grid connect mode and feed power into the base electric grid. The base grid is currently 4160 V, but will be upgraded in the near future to 12,470 V. To connect the fuel cell, a new 480/4,160/12,470 V, 300 kVA dual taps transformer is required. This will ensure that the fuel cell can quickly integrate with the new base grid system. It is recommended that a pad-mounted transformer be installed and that the high voltage side be connected to the grid at the nearby utility pole. The fuel cell will operate in the grid connect mode with no back-up power option.

The fuel cell thermal output will be used to heat the swimming pool. The outdoor pool is heated year round and is covered at night. The mechanical equipment (boilers, pumps, and filters) is scheduled to be replaced in the next several months.

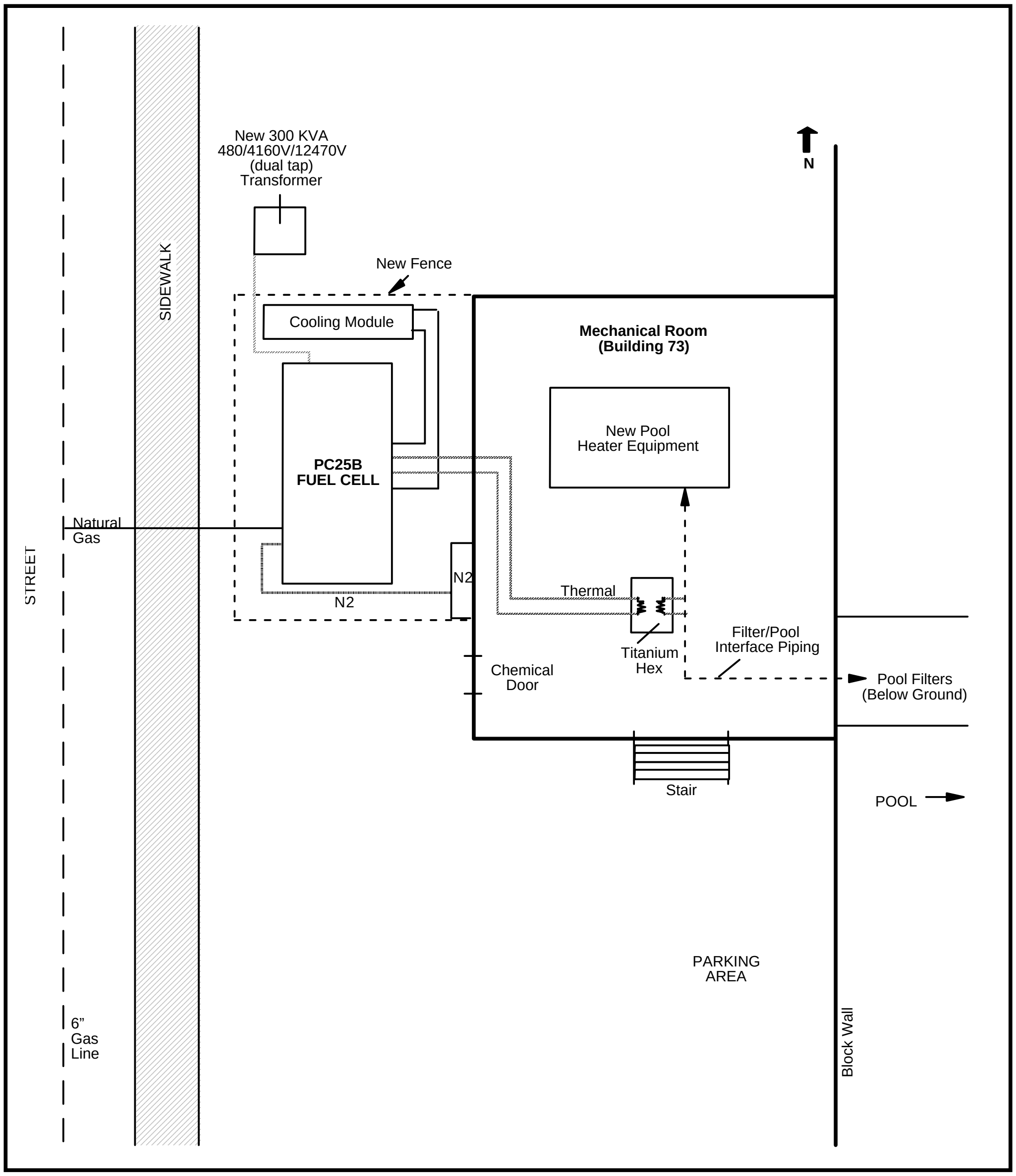

Figure 3. Fuel cell location and site interface diagram.

The fuel cell should be interfaced between the filters and the boilers. An intermediate titanium heat exchanger should be installed to isolate the fuel cell heat exchanger from the chlorinated pool water (Figure 4). Separate circulating pumps should be installed to control the flow through the fuel cell and the intermediate heat exchanger. These pumps should operate whenever the fuel cell is operating and the pool heating controls call for heat. Researchers investigated the option of raising the pool temperature to above 80 °F at night during periods of high daytime heating requirements. This option would allow fuel cell thermal output to be stored at night to offset daytime requirements.

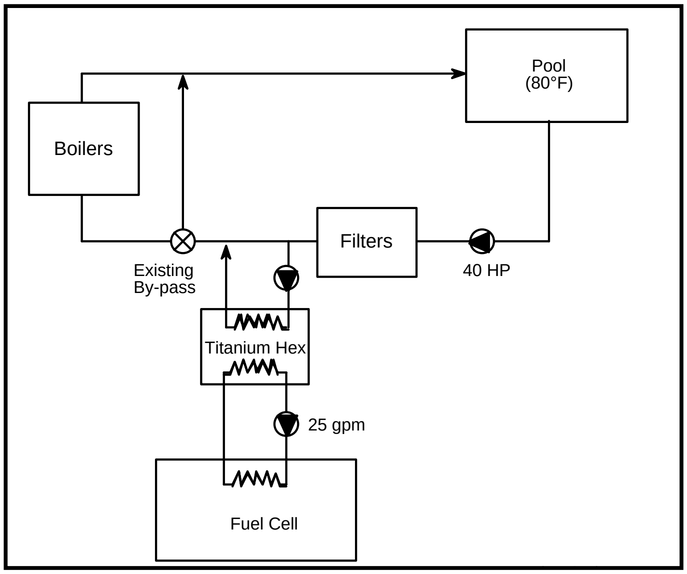

Figure 4. Fuel cell thermal interface—Port Hueneme.

The pool heating load requirement was estimated by calculating the heat loss during the day and the night times for both winter and summer periods. The heat loss from the pool was estimated using the following ASHRAE equation:

$$\text{Heat Loss (kBtu/hr)} = 10.5 * \text{Pool Surface Area (sq ft)} * [T_{H_2O}(°F) - T_{AIR}(°F)] * 1\ \text{kBtu}/1{,}000\ \text{Btu} \qquad \textbf{Eq 1}$$

This equation accounts for losses due to convection, radiation, and evaporation. It was assumed that, when the pool is covered, the evaporation loss would be reduced by 90 percent and the convection and radiation losses would be reduced by 70 percent.* Therefore, the evaporation losses at night must be subtracted from the total heat loss.

This ASHRAE equation was used to calculate heat loss due to evaporation:

$$\text{Evap. loss (kBtu/hr)} = 0.1 * \text{Surface area (°ft)} * [\text{Vapor press, } H_20 \text{ (In Hg)} - \text{Vapor Press, Air (In Hg)}] * 1\ \text{kBtu/lb} \qquad \textbf{Eq 2}$$

Since this is an outdoor pool, there will be direct solar heat gain at an estimated absorption rate of 75 percent (ref. *Solar Age*, November 1983). The ambient conditions (Table 2) were used in calculating pool heating requirements. Table 3 lists the results of the losses and heating load calculations.

* Utah Office of Energy Services, *Reducing Swimming Pool Energy Costs"* (undated brochure).

Table 2. Ambient conditions used to calculate pool heating requirements.

Description	Summer (June - August)		Winter (September - May)	
	Day	Night	Day	Night
Air Temp (°F)	66	60	62	54
R/H (%)	73	89	78	64
Water Temperature(°F)	80	80	80	80
Solar Insolation (Btu/sq ft-Day)*	1,800	—	1,300	—
Absorption Rate	0.75	—	0.75	—
Pool Hours Covered		7 p.m.-8 a.m.		6 p.m.-9 a.m.
*Ref.: SDG&E, Solar Radiation Data				

Table 3. Results of losses and heating load calculations.

Description	Summer		Winter	
	Day	Night	Day	Night
Rad./Convection Losses kBtu/hr)[3]	—	560	—	720
Evaporative Losses (kBtu/hr)[2]	—	69	—	92
Total Loss Rate (kBtu/hr)[1]	1790	629	2302	812
Hours per Day	11	13	9	15
Total Loss (MBtu/day)[4]	19.7	8.2	20.7	12.2
Solar Gain (Mbtu/day)[5]	16.4	—	11.9	—
Heating Load (MBtu/day)[6]	3.3	8.2	8.8	12.2
Heating Load Rate (kBtu/hr)[7]	300	629	978	812

Equations:

#1 = 10.5 * Pool Surface Area (sq ft) * [T_{H_2O}(°F) - T_{AIR}(°F)] * 1 kBtu/1,000 Btu

#2 = Evap. loss (kBtu/hr) = 0.1 * Surface area (sq ft) * [Vapor press, H_20 (In Hg) -Vapor Press, Air (In Hg)] * 1 kBtu/lb; reduced by 90 percent when covered at night.

#3 = (#1 - #2), reduced by 70 percent when covered at night.

#4 = #1 * hours/day * 1 MBtu/1000 kBtu

#5 = Solar insolation (Btu/sq ft-Day) * pool area (sq ft) * 1 MBtu/1,000,000 Btu * absorption rate

#6 = (#4 - #5)

#7 = (#6 / hours/day)

The calculations above show that in the summer, the fuel cell will supply 300 kBtu/hr for 11 daytime hours and 629 kBtu/hr for 13 night time hours. This is a total summer thermal utilization of 1,056 MBtu:

1,056 MBtu = [(300 kBtu/hr * 11 hr/day) + (629 kBtu/hr * 13 hr/day)] * 92 days * 1 MBtu/1,000 kBtu

During the winter, the fuel cell will supply all 700 kBtu/hr of available heat for 24 hours per day. Thus, the total winter thermal utilization is 4,586 MBtu:

4,586 MBtu = 700 kBtu/hr * 24 hr/day * 273 days * 1 MBtu/1,000 kBtu

The annual fuel cell thermal output delivered to the pool is 5,642, which represents a 92 percent thermal utilization.

5,642 MBtu = 1,056 MBtu + 4,586 MBtu

92% = 5,642 MBtu / (0.7 MBtu * 8,760 hr/yr)

Based on the calculations above, there is no need to heat the pool above 80 °F at night. This would be advantageous only if there were excess fuel cell heat available at night and not enough fuel cell heat available during the day. In the summer, the fuel cell can meet the average heating requirements for both the day and night (i.e., load is less than 700 kBtu/hr). In the winter, all of the available 700 kBtu/hr of available fuel cell heat will be used during the day and night.

3 Economic Analysis

CBC Port Hueneme purchases electricity from Southern California Edison under rate schedule TOU-8 which is a time-of-use rate schedule (Table 4):

The on-peak period is weekdays between 1200 and 1800 hours, June to September (summer). The mid-peak period is weekdays between 0800 and 1200, and 1800 to 2300 hours in the summer, and weekdays between 0800 and 2100 hours during the winter period. The off-peak period includes all remaining hours in the year, including holidays. Table 5 presents total electricity consumption and costs for the August 1995 to July 1996 time period. The average rate paid by CBC during this period was 7.14 cents/kWh.

Table 4. Southern California Edison time-of-use rate schedule (TOU-8).

	June - September	October - May
Demand ($/kW):		
Non-time related	$ 0.65	$ 0.40
On-Peak Period	$16.15	
Mid-Peak Period	$ 2.45	—
Energy ($/kWh):		
On-Peak Period	$0.07397	—
Mid-Peak Period	$0.05053	$0.06240
Off-Peak Period	$0.03755	$0.04666

Table 5. CBC Port Hueneme electricity consumption and costs.

Date	KW	Total KWh	Total Cost	$/KWh
Aug-95	8,288	3,745,600	$410,412	$0.1096
Sep-95	8,512	3,899,200	$423,137	$0.1085
Oct-95	8,800	4,075,200	$268,662	$0.0659
Nov-95	8,480	4,001,600	$246,128	$0.0615
Dec-95	8,448	3,976,000	$240,816	$0.0606
Jan-96	9,056	3,694,400	$226,882	$0.0614
Feb-96	8,832	3,918,400	$237,268	$0.0606
Mar-96	8,608	3,982,400	$239,299	$0.0601
Apr-96	8,576	3,752,000	$228,424	$0.0609
May-96	8,576	3,777,600	$212,561	$0.0563
Jun-96	8,320	3,680,000	$199,221	$0.0541
Jul-96	8,384	3,841,600	$376,050	$0.0979
Tot/Avg	8,573	46,344,000	$3,308,860	$0.0714

Table 6. CBC Port Hueneme natural gas consumption and costs.

Date	GN-30	Cost	GN-50	Cost	DFSC	Cost	Avg $/MBtu
May-95	3,753	$4,946	10,335	$6,603	14,088	$23,328	$2.48
Jun-95	2,905	$4,007	10,229	$6,442	13,135	$21,864	$2.46
Jul-95	3,639	$4,808	4,512	$3,263	8,149	$12,403	$2.51
Aug-95	5,096	$5,437	823	$825	4,232	$5,516	$1.99
Sep-95	3,963	$5,192	811	$815	4,017	$5,633	$2.44
Oct-95	4,112	$5,359	196	$855	4,308	$6,905	$3.05
Nov-95	5,347	$6,737	36	$824	5,983	$9,461	$3.16
Dec-95	5,502	$6,912	4,821	$3,302	10,322	$16,834	$2.62
Jan-96	7,616	$9,759	2,048	$1,754	9,664	$14,453	$2.69
Feb-96	7,282	$9,337	33	$824	7,314	$8,098	$2.50
Mar-96	7,694	$9,759	34	$825	7,728	$9,939	$2.66
Apr-96	7,099	$9,094	33	$824	12,125	$21,387	$4.39
Tot/Avg	64,008	$81,347	33,910	$27,156	101,065	$155,821	$2.70

Natural gas is purchased from the Defense Fuel Supply Center (DFSC) and transported by Southern California Gas Company under rate schedules GN-30 and GN-50 (cogeneration). Table 6 lists natural gas consumption, transportation, and costs for the May 1995 to April 1996 time period. The average total gas cost for this period including gas plus transportation was $2.70/MBtu.

Electric savings from the fuel cell were calculated based on the fuel cell operating 90 percent of the year (1,576,800 kWh). Demand savings were calculated assuming that the energy bill for the Site would be reduced by the full 200 kW each month. Table 7 lists the estimated full demand savings and 90 percent capacity factor savings.

Table 7. Estimated full demand savings and 90 percent capacity factor savings.

Demand	**kW**	**kW/yr**	**Rate**	**Total**
Non-Time (summer)	200	800	$0.65	$520
Non-Time (winter)	200	1,600	$0.40	$640
On-Peak (4 mos.)	200	800	$16.15	$12,920
Mid-Peak (4 mos.)	200	800	$2.45	$1,960
Demand Savings				$16,040
Energy	**hrs/yr**	**kWh/yr***	**Rate**	**Total**
On-Peak (summer)	510	91,800	$0.07397	$6,790
Mid-Peak (summer)	765	137,700	$0.05053	$6,958
Off-Peak (summer)	1,629	293,220	$0.03755	$11,010
Mid-Peak (winter)	2,249	404,820	$0.06240	$25,261
Off-Peak (winter)	3,607	649,260	$0.03755	$24,380
Energy Savings				$74,399
Port Hueneme Tax (4%)				$3,618
Total Displaced Electricity Savings				$94,057

*Hrs/Yr * 200 kW * 90% capacity factor

It was previously estimated that the pool could use 5,642 MBtu of fuel cell thermal output in a year, which is a thermal utilization of 92 percent. Assuming a 70 percent displaced boiler efficiency and a 90 percent fuel cell capacity factor, the fuel cell would displace 7,254 MBtu at the boiler plant:

7,254 MBtu = (5,642 MBtu * 90% capacity factor) / 70% boiler eff.

The fuel cell would be displacing natural gas at an average rate of $2.70/MBtu. The thermal savings from the fuel cell would be:

$19,586 = 7,254 MBtu * $2.70/MBtu

The fuel cell will consume 14,949 MBtu per year based on an electrical efficiency of 36 percent HHV (higher heating value). Input natural gas cost for the fuel cell is $40,362.

$40,362 = 14,949 MBtu * $2.70/MBtu

Table 8 lists estimated savings for the fuel cell with 100 percent demand savings and 92 percent thermal utilization. Net savings of $73,281 were calculated. For 50 percent demand savings, net savings were reduced to $64,940. Table 8 also gives savings for 100 percent thermal utilization if the Site could use all the fuel cell output.

Table 8. Economic savings of fuel cell installation.

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
Full Demand Savings:								
Max. Thermal Case	90%	100%	1,576,800	7,884	$94,057	$21,287	$40,362	$74,982
Base Case	90%	92%	1,576,800	7,254	$94,057	$19,586	$40,362	$73,281
50% Demand Savings:								
Max. Thermal Case	90%	100%	1,576,800	7,884	$85,716	$21,287	$40,362	$66,641
Base Case	90%	92%	1,576,800	7,254	$85,716	$19,586	$40,362	$64,940
Zero Demand Savings:								
Max. Thermal Case	90%	100%	1,576,800	7,884	$77,375	$21,287	$40,362	$58,300
Base Case	90%	92%	1,576,800	7,254	$77,375	$19,586	$40,362	$56,599

Assumptions:

Natural Gas Rate: $2.70/Mbtu
Electricity Rate: TOU-8 See Text
Fuel Cell Thermal Output: 700,000 Btu/hour
Fuel Cell Electrical Efficiency (HHV): 36%
Seasonal Boiler Efficiency: 70%
ECF = Fuel cell electric capacity factor
TU = Thermal utilization

The analysis is a general overview of the potential savings from the fuel cell. For the first 56 months, ONSI will be responsible for the fuel cell maintenance. Maintenance costs are not reflected in this analysis, but could represent a significant impact on net energy savings. Since detailed load energy profiles were not available, net energy savings could vary depending on actual thermal and electrical use.

4 Conclusions and Recommendations

This study concludes that the swimming pool at CBC Port Hueneme represents a good application for a 200 kW phosphoric acid fuel cell. It is recommended that the fuel cell be interfaced thermally with the pool heater/filter system to provide heating to the pool, which is required throughout the year. An intermediate titanium heat exchanger is required. The fuel cell should be located on the west side of the mechanical room near the street. Installation will require avoidance of nearby overhead power lines. A new 480/4160/12,740 V, dual taps pad-mounted transformer will be required. Natural gas can be brought in from the street. A security fence will be required.

The swimming pool should be able to recover 92 percent of the fuel cell thermal output. Net fuel cell energy savings of $73,281 were calculated for this application.

The base should check local air permit requirements as the area is known to have slightly more stringent requirements than the South Coast Air Quality Management District (SCAQMD).

Appendix: Fuel Cell Site Evaluation Form

Site Name: **U.S. Naval Construction Battalion Center**

Contacts: **Gene Crank, Rich Spiessl**

Location: **Port Hueneme, CA**

1. Electric Utility: Southern **California Edison** Rate Schedule: **TOU-8**

2. Gas Utility: **Southern California Gas** Rate Schedule: **GN-10, GN-30 DFSC supplied gas**

3. Available Fuels: **Natural gas, some fuel oil back-up**

4. Hours of Use and Percent Occupied:
   Pool Hours:
   Summer: 10:00 am - 6:00 pm (6 days/week)
   Winter: 11:30 am - 1:00 pm and 4:30 pm - 6:00 pm (Monday through Friday)

5. Outdoor Temperature Range:
   Design dry bulb temperatures: 41 °F to 75 °F
   Extremes: 35 °F to 86 °F

6. Environmental Issues: **No major issues. Air pollution district slightly more strict than SCAQMD.**

7. Backup Power Need/Requirement: **A few individual back-up generators spread around base**

8. Utility Interconnect/Power Quality Issues: **Good power quality; very few interruptions**

9. On-site Personnel Capabilities: **Currently 10 boiler operators, but boiler plant is shutting down.**

10. Access for Fuel Cell Installation: **Easy street access, but must avoid overhead power lines.**

11. Daily Load Profile Availability: **No data available.**

12. Security: **A fence will be required.**

Site Layout

Facility Type: **Swimming Pool** Age: **56 years**

Construction: **Cinder block building**

Square Feet: **1,630 sq ft (mechanical room only)**

See Figure 2

Show:

electrical/thermal/gas/water interfaces and length of runs
drainage
building/fuel cell site dimensions
ground obstructions

Electrical System

Service Rating: **4160 V distribution system on base (will soon change to 12.4 kV) Pool has mostly 208 V power.**

Electrically Sensitive Equipment: **N/A.**

Largest Motors (hp, usage): **40 H.P.**

Grid Independent Operation?: **No**

Steam/Hot Water System

Description: **Swimming pool currently heated by central steam loop. Plans are to replace this system with pool heating equipment.**

System Specifications:

Fuel Type:

Max Fuel Rate:

Storage Capacity/Type:

Interface Pipe Size/Description: **unknown, new system is planned.**

End Use Description/Profile:

Space Cooling System

Description: **None**

Air Conditioning Configuration:
Type:
Rating:
Make/Model:

Seasonality Profile:

Space Heating System

Description: **No steam at mechanical room.**

Fuel:

Rating:

Water supply Temp:

Water Return Temp:

Make/Model:

Thermal Storage (space?): **None**

Seasonality Profile:

CERL Distribution

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14. ABSTRACT

Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Researchers at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). CERL selected and evaluated application sites, supervised the design and installation of fuel cells, actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers for 29 of 30 commercially available fuel cell power plants and their thermal interfaces installed at Department of Defense (DoD) locations.

This report presents an overview of the information collected at Port Hueneme, CA, along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report.

15. SUBJECT TERMS
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energy technology alternatives
energy conservation

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